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EXAMINER	
GEORGE, PATRICIA ANN	
ART UNIT	**PAPER NUMBER**
1765	

DATE MAILED: 08/04/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)	
	10/721,448	BRASK ET AL.	
	Examiner	Art Unit	
	Patricia A. George	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 24 May 2006.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-22 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-22 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 5/24/2006 has been entered.

Drawings

The drawings were received on 5/24/2006. These drawings overcome the objection of 2/22/2006.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

> This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 4, 8, 9, 11, 12, 16, 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. (6,850,683) in view of Wolf et al. (Silicon Processing for the VLSI Era, Vol. 1 , Lattice Press (1986)), Bierhoff (Influence of the Cross Sectional Shape of Board-integated Optical Waveguides on the Propagation Characteristics; Univ. of Paderdorn, Germany; presented at 6th IEEE-SPI Workshop; 5/13/2002), Yates et al. (6,703,319), and Patel et al. (2004/0240822).

As to claim 1, Lee discloses a method, comprising: etching a waveguide (108) (column 2, lines 58-62*, Figure 2) isotropically to smooth a surface (1 10) (column 2, lines 61-62) of the waveguide (column 4, lines 4-19', Figure 4).

Lee does not expressly disclose that etching the waveguide comprises submerging the waveguide in a wet etch solution, as in applicants' limitation of claim 1.

However, Wolf teaches that wet etching is typically performed by dissolution of the material to be etching in a liquid solvent (or submerging the sample in a wet etch solution) (pages 529-530).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to submerge the waveguide in a wet etch solution. One who is skilled in the would be motivated to wet etch according to conventional methods that are well known.

Lee et al. is silent as to the shape of the waveguide, trapezoidal anisotropic, as in applicants' limitation of claim 1.

Bierhoff teaches waveguides with trapezoidal cross sections are a good choice to improve the attenuation behaviour of waveguides (see Conclusions on slide 18), and further illustrates trapezoidal waveguides are anisotropic (see Modelling the cross sectional shape on slide 10). Bierhoff also presents radiation loss is directly related to surface roughness, i.e. a smoother surface has less power loss (see slide 17).

Therefore it would have been obvious to one of ordinary skill in the art at the time of invention was made, to form a waveguide in the shape of trapezoidal anisotropic having a smooth surface.

Lee does not expressly disclose applying sonic energy to the wet etch solution while etching, as in applicants' limitation of claim 1.

Yates et al. teaches that one skilled in the art would recognize that megasonic energy or ultrasonic energy (as in claim 9) may be used in conjunction with cleaning (i.e. etching) compositions (col. 6, l. 57-64) while using hot phosphoric acid (col.2, line 4) to advantageously clean semiconductor wafers with dielectric layers (col.7, l. 14).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply megasonic energy to the wet etch solution while etching the waveguide isotropically, because Yates teaches one skilled in the art would recognize its use and it would clean advantageously.

Lee et al. is silent as to forming a waveguide having a rounded surface, as in applicants' limitation of claim 1.

Patel et al. teaches as the waveguide shape approaches a rounded shape, more of the propagating optical signal will remain guided along the length of the waveguide.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a waveguide having a rounded surface, as in applicants' limitation of claim 1.

As to claim 4, Lee discloses reactive ion etching (i.e anisotropically etching) (col. 3, lines 32-34) the waveguide before etching the waveguide isotropically (i.e wet etching) (column 4, lines 7-11).

As to claim 8, Lee does not expressly disclose megasonic energy in the range of 800 kldz - 1200 kHz.

However, Wolf teaches that conventional megasonics use higher frequency of 850 kHz (page 519, Figure 3).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use megasonic energy in the range of 800 kHz - 1200 kHz. One who is skilled in the art would be motivated to use a conventional frequency, known to remove particulates.

As to claim 11, Lee does not expressly disclose the wet etch solution comprises an acid compatible with temperatures above approximately 70C and etches stoichiometric silicon nitride and is selective to dielectric materials. Wolf further teaches

that wet etching, a generally isotropic process, is widely used for producing semiconductor devices because it is low cost, reliable, and a high throughput process with excellent selectivity with respect to both masks and substrate materials (page 529). Wolf teaches that silicon nitride is etched in 85% phosphoric acid at 180C, with silicon oxide as an etch mask (page 534). In other words, silicon nitride is conventionally etched with phosphoric acid with temperatures above approximately 70C and is selective to silicon oxide.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a wet isotropic etch, because Wolf teaches that wet etching is widely used for producing semiconductor devices due to its low cost, reliable, and a high throughput process with excellent selectivity with respect to both masks and substrate materials. Moreover, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a wet etch solution comprising an acid compatible with temperatures above approximately 70C and etches stoichiometric silicon nitride and is selective to dieletric materials. One who is skilled in the art would be motivated to use a conventional wet etching solution, such as phosphoric acid, known to accomplish the task of etching silicon nitride.

As to claim 12, Wolf discloses that the wet etch solution comprises approximately 84% by volume phosphoric acid in water (page 534).

As to claim 16, Lee does not expressly disclose etching the waveguide for a time

sufficient to smooth the surface of the waveguide to maximize retention of a light signal ithin the waveguide.

However, Lee teaches etching the waveguide to smooth the surface of the waveguide (column 4, lines 4-19). Furthermore, Lee teaches that reducing the optical losses through smoothing the surface of the waveguide (column 4, ines 4-10).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to etch the waveguide for a time sufficient to smooth the surface of the waveguide to maximize retention of a light signal within the waveguide. One who is skilled in the art would be motivated to reduce the optical losses through smoothing the surface of the waveguide.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim 20 rejected under 35 U.S.C. 102(b) as being anticipated by Lee.

As to claim 20, Lee discloses a method, comprising'. maximizing retention of an intensity of a light signal within a waveguide (column 3, lines 45-48) by etching a waveguide isotropically to smooth a surface of the waveguide (column 4, lines 4-19).

Claim Rejections - 35 USC § 103

Claim 21 rejected under 35 U.S.C. 103 as being unpatentable by Lee, as in claim 20 above, in further view of Lee.

As to claim 21, Lee does not expressly disclose that the light intensity loss of a substantially smoothed waveguide is approximately 6 dB/cm.

Lee discloses a light intensity loss of a substantially smoothed waveguide of approximately 0.8 dB/cm (column 3, lines 45-48). Moreover, Lee teaches reducing the optical losses through smoothing the surface of the waveguide (column 4, lines 4-10). In other words, surface smoothness of the waveguide is correlated to with optical losses. If an optical loss of 6 dB/cm is desired, one who is skilled in the art would reduce the number of smoothing steps.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to smooth the waveguide with a light intensity loss of approximately 6 dB/cm. One who is skilled in the ad would be motivated to reduce the number of process step for fabricating the optical device.

Claim Rejections - 35 USC § 103

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., Wolf et al., Bierhoff, Yates et al., and Patel et al. as applied to claims 1, 4, 8, 9, 11, 12, and 20 above, further in view of Awad (Ultrasonic Cavities and Precission Cleaning; 11/1996).

As to claim 10, Lee does not expressly disclose megasonic energy in the range of 1 kHz-50 kHz.

As to claim 10, Awad discloses that the ultrasonic (i.e. megasonic) energy is in the approximate range of 20-120 kHz (page 2, para. 2, line 4). Awad teaches several advantages to use of this range, including removal is consistant and uniform, regardless of the complexitiey and geometry of the substrate (pg. 2, para. 1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to use megasonic energy in the range of 20-120 kHz.

Claim Rejections - 35 USC § 103

Claims 3 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., Wolf et al., Bierhoff, Yates et al., and Patel et al. as applied to claims 1, 4, 8, 9, 11, 12, 16, 20, and 21 above, further in view of Ishida et al. (U.S. Patent No. 4,695,122).

As to claims 3 and 22, Lee discloses that the waveguide comprises silicon (column 2, lines 54-55).

Lee does not expressly disclose that the waveguide comprises amorphous silicon.

Ishida teaches forming the waveguide of amorphous silicon and by changing sputtering conditions and sputtering gases, the refractive index of the silicon can be readily adjusted (column 2, lines 29-40). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a waveguide

comprising of amorphous silicon. One who is skilled in the ad would be motivated to use a material in which the refractive index of the silicon can be readily adjusted.

Claim Rejections - 35 USC § 103

Claim 7 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., Wolf et al., Bierhoff, Yates et al., and Patel et al. as applied to claims 1, 4, 8, 9, 11, 12, 16, 20 and 21 above, further in view of Li (U.S. Patent No. 5,976,767).

As to claim 7, Lee does not expressly disclose that the sonic energy is megasonic.

However, Li teaches that the application of megasonics during wet etching combines chemical and physical forces, increasing the material removal rate of the etch (column 6, lines 12-18).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use sonic energy that is megasonic. One who is skilled in the art would be motivated to increase the material removal rate of the etch.

As to claim 15, Li discloses performing isotropic etch at a temperature in the approximate range of 24C-70C (column 4, lines 57-59).

Claim Rejections - 35 USC § 103

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., Wolf et al., Bierhoff, Yates et al., and Patel et al. as applied to claims 1, 4, 8, 9, 11, 12,

16, 20, and 21 above, further in view of Patel et al. (2004/0240822) and Newn et al. (3,999,835).

As to claim 2, Patel discloses a method, comprising: etching a waveguide (54) to smooth a surface (66/68) of the waveguide (paragraph 0039., Figures 12-15).

Patel does not expressly disclose that the etch is isotropic', and that the waveguide comprises stoichiometric silicon nitride. However, Patel teaches that smoothing of the sidewalls (66/68) and surfaces of the waveguide (54) can be achieved by plasma etching (paragraph 0039). Moreover, the smoothing of waveguide (54) results in a reduction in optical scattering losses (paragraph 0039).

Wolf teaches that plasma etching is isotropic (page 541).

Newn teaches that stoichiometric silicon nitride is a material suitable for forming an optical waveguide (column 2, lines 1 1-23).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to etch isotropically, because Patel teaches that smoothing of the waveguide with a plasma (or isotropic etch) results in a reduction in optical scattering losses. Moreover, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the waveguide with stoichiometric silicon nitride, because Newn teaches that silicon nitride is conventional material suitable for forming an optical waveguide.

Claim Rejections - 35 USC § 103

Claims 13, and 14, are rejected under 35 U.S.C. 103(a) as being unpatentable over Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., Wolf et al., Bierhoff, Yates et al., and Patel et al. as applied to claims 1, 4, 8, 9, 11, 12, 16, 20 and 21, further in view of Ilardi (5,466,389).

Ilardi teaches the use of an ammonia hydroxide solution having a PH of 8 to 10 with a non-metallic base (column 2, lines 29-34) directed at cleaning silicon wafers (column 1 , lines 15-17). Moreover, Ilardi teaches, the alkaline composition reduces wafer surface roughness (column 2, lines 34-37). It should also be noted that there is overlap between Applicants' and Ilardi's PH ranges. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a wet isotropic etch and to submerge the waveguide in a wet etch solution, because Wolf teaches that wet etching is widely used for producing semiconductor devices due to it is low cost, reliable, and a high throughput process with excellent selectivity with respect to both masks and substrate materials. Moreover, it would have been obvious to one of ordinary skill in the art at the time the invention was made to an ammonia hydroxide wet etch solution, because Li teaches that an ammonia hydroxide solution is beneficial due to its selective to dielectric materials and organic photoresist.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the wet etch solution having a PH in the approximate range of 10-13, as in applicants' claim 13.

One who is skilled in the art would be motivated to select range similar to Ilardi, because Ilardi teaches that alkaline solutions reduce surface roughness.

As to claim 14, Ilardi discloses that the base is a non-metallic base (column 2, lines 29-37).

Claim Rejections - 35 USC § 103

Claims 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Patel, in view of Bierhoff, Wolf, and Li.

As to claim 17, Patel discloses a method comprising: forming an amorphous silicon layer (50) on a first dielectric layer (3) (paragraphs 0038, 0032); etching the amorphous silicon layer (50) with a dry plasma etch to form at least one waveguide (54) (paragraphs 0038); and forming a second dielectric layer above the at least one waveguide (paragraph 0005).

Patel teaches rectangular waveguides, not trapezoidal anisotropic, as in applicants' limitation of claim 1.

Bierhoff teaches waveguides with trapezoidal cross sections are a good choice to improve the attenuation behaviour of waveguides (see Conclusions on slide 18), and further illustrates trapezoidal waveguides are anisotropic (see Modelling the cross

sectional shape on slide 10). Bierhoff also presents radiation loss is directly related to surface roughness, i.e. a smoother surface has less power loss (see slide 17).

Therefore it would have been obvious to one of ordinary skill in the art at the time of invention was made, to form a waveguide in the shape of trapezoidal anisotropic having a smooth surface.

Patel does not expressly disclose an anisotropic dry plasma etch; and submerging the at least one waveguide in an ammonia hydroxide isotropic wet etch solution to which sonic energy is being applied at approximately room temperature for a time sufficient to smooth the a surface of the waveguide.

Wolf teaches that anisotropic etching results is greater dimensional control of etched features (page 551).

Patel teaches that smoothing of the sidewalls (66/68) and surfaces of the waveguide (54) can be achieved by plasma etching (paragraph 0039). Moreover, the smoothing of waveguide (54) results in a reduction in optical scattering losses (paragraph 0039).

Wolf teaches that plasma etching is isotropic (page 541). Wolf further teaches that wet etching, a generally isotropic process, is widely used for producing semiconductor devices because it is low cost, reliable, and a high throughput process with excellent selectivity with respect to both masks and substrate materials (page 529). Li teaches a method of etching silicon using an ammonia hydroxide wet etch solution to

which sonic energy is being applied at approximately room temperature (column 2, lines 25-34).

Li further teaches that sonic energy removes silicon at a faster rate (column 2, lines 33-35) and that such an ammonia hydroxide solution is beneficial because it is selective to organic photoresist (column 2, lines 6-10), unlike many other commercial silicon etchants (column 1, lines 53-65). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use an anisotropic dry plasma etch.

One who is skilled in the art would be motivated to achieve greater dimensional control over etched features. Furthermore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a wet isotropic etch, because Wolf teaches that wet etching is widely used for producing semiconductor devices due to its low cost, reliable, and a high throughput process with excellent selectivity with respect to both masks and substrate materials.

Moreover, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use an ammonia hydroxide isotropic wet etch solution to which sonic energy is being applied, because Li teaches that an ammonia hydroxide solution is beneficial due to its selectivity to organic photoresist and that sonic energy removes silicon at a faster rate.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to etch for a time sufficient to smooth the surface of the

waveguide, because Patel teaches that smoothing of waveguide results in a reduction in optical scattering losses.

As to claim 18, Li discloses that the isotropic etch for amorphous silicon is a wet etch solution comprising ammonium hydroxide in the approximate range of 2%-10% by volume in water (column 2, lines 25-34).

As to claim 19, Patel does not expressly disclose that the sonic energy impacts the waveguide with a power in the approximate range of 0.5 W/cm - 10 W/cm2

Li teaches that sonic energy removes silicon at a faster rate (column 2, lines 33-35) because sound waves travel through the etch solution and facilitate the removal of particles (column 6, lines 12-18). Moreover, Li teaches that for the removal of microscopic particulate matter from a semiconductor wafer (column 1, lines 16-21), a sonic power density of 5 to 10 W/cm 2 is conventional (column 1 lines 50-55).

Therefore, it would have been obvious to one of ordinary skill in the ad at the time the invention was made to use a power in the approximate range of 0.5 W/cm - 2 10 0 W/cm2. One who is skilled in the art would be motivated to use a power density known to accomplish the task of removing particulate matter from an etched surface.

Response to Arguments

Applicant's arguments, on page 8, regarding Lee, Wolf, and/or Hembree not teaching or suggesting the amended claimed invention are persuasive. However, upon further consideration, a new ground(s) of rejection is made above.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Patricia (Patty) George whose telephone number is (571)272-5955. The examiner can normally be reached on weekdays between 7:00am and 4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571)272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Patricia A George
Examiner
Art Unit 1765

PAG
07/06

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